**IMMUNE SYSTEM STUDY GUIDE**

* Body Defense – Types (body cannot survive without both)

1. Non-specific body defense (innate)

* Respond to any injury
* Always respond
* Immediate response
* Local response

1. Specific body defense (adaptive)

* Respond to specific substance
* Need to be activated
* Latent period
* Systemic response
* Non-specific Body Response

1. Physical barrier (most reliable barrier the body has, but the least credited)

* Skin (outside), mucosa (inside)
* Acid (secretions) pH <7 discourages bacterial growth
  + Acid mantle of the skin
  + Gastric HCl
  + Vaginal secretions
* Lysozyme – mildly antiseptic, suppress bacterial growth
  + Produced by saliva, and lacrimal secretions
* Mucus – filters pathogenic particles
  + Traps debris
  + *“mucus is good – don’t knock it!” lol*

1. Phagocytes

* Neutrophils (most common) – limited capacity to kill
* Macrophages – potent phagocyte (derived from monocytes, which become macrophages within 12 hours of leaving the bloodstream!)
* Mast Cells – allergic reaction – release histamines
* NK Cells (natural killer cells) – able to recognize cancer cells
* Immuno-surveillance theory = mutations occur naturally among large amounts of cell divisions, so cancer processes begin often, but it does not always develop into disease due to the actions of NK cells. The theory states that people with strong NK cells are more resistant to cancer processes!

1. Anti-Microbial proteins (anti-virals)

* Interferon (IFN) – proteins produced by activated lymphocytes, macrophages, etc.
* Anti viral infection
* Alpha IFN, Beta IFN, etc.
* When a virus invades a cell, its nucleic acid turns on an interferon-producing gene 🡪 mRNA 🡪 translation into interferons. These interferons bind to active sites of healthy cells and allow them to synthesize a protein that blocks invading viruses from multiplying.
* Not virus-specific
* They also activate macrophages and mobilize NK cells.
  + Therein have an anticancer function

1. Inflammation

* Outcome – goals:
* Localize damaging agents – restrict the spread
* Neutralize pathogens – suppress multiplication
* Repair tissue damage – caused by pathogens
* Inflammatory Process

1. Vascular changes  
   (responsible for clinical signs of inflammation)

* Vasodilation + Increase in capillary permeability 🡪 ↑ blood flow 🡪 swelling, redness, and pain
* Vasodilation 🡪 redness and heat
* ↑ Capillary permeability 🡪 Swelling 🡪 Pain

1. Phagocytic mobilization (phagocytes spill cell contents causing damage/lysis)

* Inflammatory mediators (trigger rxns of phagocytes)  
  🡪 mobilize phagocytes (leukocytosis: neutrophils move from bone marrow to blood)  
  🡪 margination (pavement) (stick to the edge of the blood vessel, with help of signaling CAMs)  
  🡪 diapedesis (cells flatten and move out of blood vessel)  
  🡪 phagocytosis (kill foreign microbes)

**VOCAB:**  
Chemotaxis – attraction of phagocytes to the site of inflammation by inflammatory mediators

* Complement System
  + A group of bloodborne proteins that enhance the inflammatory and immune response.
  + complements antibody activity
  + complements the activity of both innate and adaptive defenses
  + Made of plasma proteins
* Complement Activation/Fixation

1. C1 to Antigen-Antibody Complex

* Ab activation of C protein  
  🡪 🡪🡪 C3🡪 C3a + C3b  
   ↑ = final important step in activation
* Antibodies on the surface of a pathogen activate complement proteins C1, C4, and C2, which activate C3. C3 then divides into C3a and C3b.
  + C3a promotes inflammation
  + C3b promotes phagocytosis (acts as an opsonin)

1. Antigen + C protein 🡪🡪C3b

* Spontaneous activation of C protein
* C3b complex binds to bacteria 🡪 Helps in formation of Membrane attack complex (MAC) 🡪 lysis
  + MAC – destroys cell membranes
  + Creates a funnel-shaped pore in the membranes of target cells
  + This destroys cells because it induces a massive influx of water!
* Function of Complement

1. Amplify inflammation 🡪 activated complement system amplifies inflammatory response
2. Kill bacteria by lysis 🡪 MAC-attack
3. Enhance phagocytosis through opsonization

* Can be non-specific or specific
* Can be harmful or helpful
* Fever
* Low-grade fever >98.6° and <100.4° (beneficial)
* High-grade fever >104° (dangerous)
* ↑ Metabolism 🡪 ↑ tissue repair
* ↑ fever 🡪 ↓ bacterial proliferation
* Once a fever hits 106°, it can cause irreversible brain damage
* How do you control a baby’s fever? Never use cold water – use lukewarm water to gently bring down the body temperature.
* Specific Body Defense

(Immune response)

* Ag-specific
* Needs activation
* Systemic response – whole-body involvement
* It has memory – can last a lifetime, or less (ie: some vaccines require regular boosters, whereas others do not)
* 2 arms

1. Ab-mediated immunity (AKA B-cell immunity AKA humoral immunity)  
   B-cells-Ab
2. Cell-mediated immunity  
   T-cells kill target cells
   * Either directly
   * Or indirectly, by releasing chemical mediators that enhance the inflammatory response or activate other lymphocytes or macrophages

* APC’s – antigen-presenting cells – serve auxiliary functions
  + Dendritic cells
  + Macrophages
  + B-cells
* Lymphocytes
  + Learn Self-Tolerance and Immunocompetence
  + Called “naïve” before they’ve been exposed to antigens
  + Once exposed, they react to one specific antigen determinant (have a unique type of receptor on their surface)
  + Exposed cells become effector cells or memory cells
* Antigen (Ag) – foreign molecules

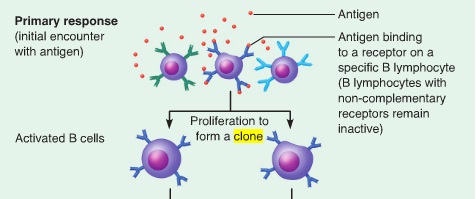
1. Complete Ag

* Molecule induces immune response
* Has immunogenicity AND reactivity
  + Immunogenicity occurs at antigenic determinants (Ab or lymphocyte receptor binding sites)
    - Large proteins (complex molecules) have hundreds of antigenic determinants, which explains why they have a great deal of immunogenicity and reactivity.
    - Large simple molecules have relatively little immunogenicity, so they make the best implants.
* Proteins are the strongest antigens

1. Hapten

* Incomplete Ag – does not evoke immune response
* Has reactivity but not immunogenicity
* Small molecules
* Can turn into a complete Ag
  + Can link with larger protein molecules, and the immune see these links as “foreign”
* Ex: drugs – ie: Penicillin – can become Antigenic through sensitization over the course of repeated exposures
* Self-Ag
  + Body recognizes foreign Ag in that it is not a self-Ag
* MHC proteins (Major Histiocompatibility Complex)
  + Chromosome 6 contains code for these glycoproteins
  + Each MHC molecule displays a peptide – peptides play a crucial role in mobilizing adaptive defenses

1. Class I MHC proteins (Identification purpose)
   * Found on virtually all body cells
   * somatic cells, except RBCs (because they are annucleate)
   * Peptides come from within the cell
2. Class II MHC proteins (recognize foreign cells)
   * Found only on immune cells –Antigen-presenting cells; macrophages
   * Peptides come from outside the cell

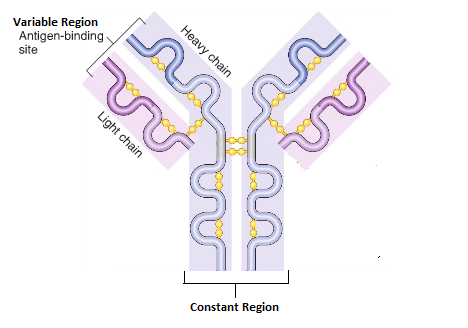
* Humoral Immunity  
  (Ab-mediated immunity)
* Clonal Selection  
  Ag 🡪 B cell 🡪 Clones 🡪 (1) Plasma Cells 🡪 Ab production  
   (2) Memory cells (if a person is exposed to the same Ag again   
   🡪 Ag production occurs more quickly)  
  
  + Ag-activated B cells undergo cell division
* Immunological Memory

1. Primary immune response

* 1st exposure to Ag 🡪 latent period (7-14d) 🡪 Ab production

1. Secondary exposure to same Ag

* Ab production (much quicker)
* Ab (Immunoglobulin, Ig)
* Ab structure

1. 2 heavy chains
2. 2 light chains
3. Constant region
4. Variable region (area where Ag binds)

* Ab Classes
  + IgG, IgM, IgA, IgD, IgE
* Ab Functions
  + They have a PLAN of action
    - Precipitation, Lysis (through complements), Agglutination, Neutralization

1. Neutralization (of Ag) – Ab binds to active site of Ag
2. Precipitation – change soluble molecules into insoluble ones
3. Agglutination – (ie: blood type incompatibility) Ab binds to foreign Ag – clumping occurs
4. Complement Fixation (amplification of inflammatory/immune response)
5. Opsonization – “making it tasty” – Ab binds to bacterium 🡪 coats it, making it easier to phagocytize

* Active Humoral Immunity

1. Naturally acquired immunity

* Ex: exposure to pathogens

1. Artificially acquired immunity

* Ex: Vaccinations – small pox, polio, etc.
* Vaccination eliminates the mortal danger of direct exposure to deadly diseases
* Passive Humoral Immunity

1. Naturally acquired

* Colostrum – first milk produced after giving birth, which contains antibodies

1. Artificially acquired

* Ex: antidotes – rabies shots
* Does not involve the body making its own Ab – these are made by other organisms, harvested, and injected into the person who requires immunity
* Cell-Mediated Immunity
  + Useful when dealing with infectious microorganisms that slip inside body cells to multiply
* 3 major types of T-cells

1. Helper T-cells (CD4 cells) (TH)
   * Initiate immune response
2. Cytotoxic T-cells (CD8 cells) (Tc)
   * Destroy target cells – foreign cells
   * Perforin – molecule secreted from TC, creates pores in target cell’s membrane, so that granzymes can enter and enduce apoptosis
3. Supressor/Regulator T-cells (CD8 cells) (TReg)
   * Wind-down immune response
   * (These cells may be dysfunctional in people who have ↑↑ allergies)

* T-cell Activation
  + Occurs on the surface of an APC
  + Both of these 2 steps have to occur in order for T cell to proliferate and differentiate

1. Exposure to Ag
   1. TCRs bind to an antigen-MHC complex on an APC
   2. The T cell is stimulated by antigen-binding…
2. Costimulation
   * T cells have to bind to other surface receptors on an APC
   * Cytokine (molecule secreted by immune cells) from APC  
     🡪 T-cells activated, proliferate, differentiate.
   * If no costimulation occurs, the T cell becomes unresponsive to the antigen (anergy)

* CLINICAL: Immune Disorders
  + SCID – severe combined immunodeficiency syndromes
    - Marked deficit of T and B cells
  + AIDS – victims are 75% female and 25% male…. Why?
    - Interferes with the activity of Helper T cells
* Autoimmune Diseases (loss of ability to recognize self-Ag)
  + MS (demyelination of axons)
  + Grave’s Disease (an antigen acts like TSH, causing the thyroid gland to significantly increase production of thyroxine)
  + Type I Diabetes (body attacks beta cells)
  + RA (destroys joints)
* Hypersensitivity (allergic rxn)
  + A decrease in Regulatory T cells may be an underlying cause.
  + Type I
    - Hay Fever
    - Anaphylaxis
    - Poison Ivy